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SPECIFICATION FOR LABORATORY
ELECTRICAL RESISTANCE FURNACES

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ELECTRICAL RESISTANCE FURNACES

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Indian Standard

SPECIFICATION FOR LABORATORY ELECTRICAL RESISTANCE FURNACES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 July 1977, after the draft finalized by the Electrical Appliances Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 Laboratory furnaces are general purpose furnaces not designed to heat any specific loads. Since the type of load and its disposition within the furnace may affect the temperature distribution and other characteristics to a very large degree and since it is not possible to define a standard load the test conditions specified in this standard require the furnaces to be tested empty.

0.3 In this standard, references with regard to general and safety requirements as well as method of tests have been made to IS : 302-1973*, which is a necessary adjunct to this standard. Should, however, any deviation exist between the requirements of IS : 302-1973* and those of this standard, the provisions of the latter shall apply.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard applies to general purpose alternating current laboratory electrical resistance furnaces which are not designed for heating any specific types of load, which have rating up to 8 kW and maximum temperature not exceeding 1 250°C, and which have static atmosphere of air. The standard will apply to furnaces of the above description having box or tube form, horizontal or vertical, and with exposed or concealed elements.

*General and safety requirements for household and similar electrical appliances (*fourth revision*).

†Rules for rounding off numerical values (*revised*).

1.2 This standard does not apply to special purpose laboratory electric furnaces, such as those designed for coal ashing, differential thermal analysis, etc, or furnaces designed to work under vacuum or with forced air or other gas atmospheres.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Furnace — A closed heating chamber constructed with refractory non-metallic material for the inner lining, where the heat is transferred to the load predominantly by radiation from the lining and/or heating element.

2.2 Stated Performance — The maximum temperature and limits of temperature variation and differential specified by the manufacturer for the particular model and size of the furnace under test.

2.3 Working Space — The space within the furnace where the stated performance is achieved.

2.4 Furnace Temperature — The temperature at the geometrical centre of the working space.

2.5 Indicated Temperature — The temperature indicated by a suitable indicating device fixed on the furnace as standard equipment or recommended by the manufacturer and fixed in accordance with his instructions.

2.6 Maximum Temperature — The highest furnace temperature at which the furnace is designed to operate without unduly shortening its life.

2.7 Steady State Period — The period, when operating under standard test conditions, when the mean power consumption is the minimum necessary to maintain the given temperature.

2.8 Average Maximum Temperature — The arithmetical mean of successive maximum temperatures occurring in a specified number of temperature cycles during a steady state period.

2.9 Average Minimum Temperature — The arithmetical mean of successive minimum temperatures occurring in a specified number of temperature cycles during a steady state period.

2.10 Mean Temperature — The arithmetical mean of maximum and minimum temperatures over the same specified number of temperature cycles.

2.11 Temperature Variation — The difference in the temperature recorded at the centre of the working space and at any other point in the working space at any instant.

2.12 Temperature Differential — The cyclic change of temperature at any point in the working space as measured by the difference between the average maximum and average minimum temperatures at that point.

2.13 Temperature Drift — The change in the furnace temperature over a long time during the steady state period.

2.14 Heating-Up Time — The time required to attain the specified maximum temperature after switching on the supply to the furnace.

2.15 Stabilization Time — The time measured from the end of the heating up period to the beginning of the steady state period.

2.16 Thermal Loss — Rate of loss of heat during a steady state period.

3. RATING

3.1 Voltage Rating — The provisions of 3.1 of IS : 302-1973* shall apply.

3.2 Rated Input — The provisions of 3.2 of IS : 302-1973* shall apply.

4. MATERIALS AND COMPONENTS

4.1 The materials and components used in the assembly and construction of laboratory electric resistance furnaces shall conform to the relevant Indian Standards wherever they exist.

5. CONSTRUCTION

5.1 The relevant provisions of 7 of IS : 302-1973* shall apply in addition to the requirements stated in 5.2 to 5.7.

5.2 Cabinet — The cabinet or housing of the furnace shall be constructed from C.R.C.A. mild steel sheets of a thickness of at least 1.2 mm.

5.3 Refractory Liners — The refractory liners or muffles used in a furnace shall either be monolithic castings or shall be constructed and joined together so that no straight leakage paths from the inner working space are likely to be produced by shrinkage of the jointing material.

*General and safety requirements for household and similar electrical appliances (fourth revision).

5.4 Door or Lid — The door or lid of the furnace shall be so designed and constructed that when fully opened, it shall not obstruct the access to the working space or pose a hazard owing to its liner being at a very high temperature.

5.5 Heating Elements — The heating elements of a furnace shall be so designed and located that the temperature gradient between any part of the element and the centre of the working space shall not exceed 200°C in the case of concealed or embedded elements and 100°C in the case of exposed elements.

5.5.1 Exposed elements shall be so arranged and connected that they are isolated from the supply whenever the furnace door or lid is opened.

5.6 Wiring and Components — The wiring and components used in a furnace shall be constructed or fixed in such a manner that they shall be able to withstand continuously the temperature to which they are likely to be exposed when the furnace is operated at its maximum temperature.

5.7 Temperature Indicator — A suitable temperature indicator or pyrometer capable of reading temperatures with the desired accuracy shall be provided on the furnace or alternately arrangement shall be provided for fixing such an instrument with its sensitive element well within the working space.

6. GENERAL AND SAFETY REQUIREMENTS

6.1 Protection Against Electric Shock — The provisions of **8** of IS : 302-1973* shall apply.

6.2 Temperature-Rise Limit — The provisions of **10.1** of IS : 302-1973* shall apply.

6.3 Electrical Insulation — The provisions of **11** of IS : 302-1973* shall apply.

6.4 Stability — The provisions of **14.2** of IS : 302-1973* shall apply.

6.5 Mechanical Strength — The provisions of **15** of IS : 302-1973* shall apply.

*General and safety requirements for household and similar electrical appliances (fourth revision).

6.6 Supply Connections — The provisions of **20** IS : 302-1973* shall apply.

6.7 Terminals — The provisions of **21** of IS : 302-1973* shall apply.

6.8 Earthing — The provisions of **22** of IS : 302-1973* shall apply.

6.9 Screws and Connections — The provisions of **23** of IS : 302-1973* shall apply.

6.10 Resistance to Rusting — The provisions of **7.33** of IS : 302-1973* shall apply.

7. PERFORMANCE REQUIREMENTS

7.1 Input — The provisions of **9** of IS : 302-1973* shall apply.

7.2 Thermal Performance — The furnace shall satisfactorily pass the tests specified in **9**.

8. MARKING AND INSTRUCTIONS FOR USE

8.1 Each furnace shall be marked indelibly and clearly with the information prescribed in **25.1** of IS : 302-1973* on its outer surface or on a name-plate attached thereto.

8.1.1 Stated Performance — The manufacturer shall include either in the information marked on the furnace or in the instructions for use supplied with the furnace the following performance details:

- a) Maximum temperature;
- b) The heating-up time;
- c) The extent and location of the working space;
- d) The temperature variation;
- e) In the case of furnaces fitted with a temperature controller only, the temperature differential and drift;
- f) In the case of furnaces fitted with a temperature fuse, the fusion temperature; and
- g) In the case of furnaces fitted with a thermal cut-out, the cut-out temperature.

*General and safety requirements for household and similar electrical appliances (fourth revision).

8.1.2 The furnace may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8.2 Marking of Earth Terminal — The symbol  shall be marked prominently on or adjacent to the earth terminal, if provided.

8.3 Instructions for Use — Each furnace shall be provided with the necessary instructions including precautions to be taken for its proper and safe use. If the pyrometer requires occasional recalibration in normal use the instructions should specify the period after which such recalibration may be necessary.

8.4 The words 'READ INSTRUCTIONS BEFORE USE' should appear prominently on the furnace.

9. TESTS

9.1 Categories of Tests

9.1.1 Type Tests — The tests specified in Table 1, shall constitute type tests and shall be carried out on two samples of furnaces of the same type and rating (selected preferably at random from a regular production lot).

9.1.1.1 Criteria of acceptance — All samples shall successfully pass all the type tests for proving conformity with the requirements of this standard. If any sample should fail in any of the type tests, the testing authority at its discretion may call for fresh samples not exceeding twice the original number and subject them again to all the tests or to the tests in which failure occurred. No single failure shall be permitted in repeat test(s).

9.1.2 Acceptance Tests — The following shall constitute the acceptance tests:

- a) Visual examination and inspection (see 9.3.1),
- b) Protection against electric shock (see 40 of IS : 302-1973*),

*General and safety requirements for household and similar electrical appliances (fourth revision).

- c) Insulation resistance and leakage current (hot) (*see* 42 of IS : 302-1973*),
- d) Earthing connection (*see* 38 of IS : 302-1973*),
- e) Input (*see* 45 of IS : 302-1973*),
- f) Temperature-rise limit (*see* 41 of IS : 302-1973*),
- g) Temperature variation (*see* 9.3.2),
- h) Temperature differential (applicable to furnaces provided with a temperature controller (*see* 9.3.2), and
- j) Temperature fuse or cut-out (applicable to furnaces not provided with a temperature controller (*see* 9.3.4 or 9.3.5).

The method of sampling shall be as agreed to between the manufacturer and the user.

TABLE 1 SCHEDULE OF TYPE TESTS

(*Clause* 9.1.1)

SL No.	TEST	CLAUSE REFERENCE
(1)	(2)	(3)
i)	Visual examination and inspection	9.3.1
ii)	Fire resisting property	29 of IS : 302-1973*
iii)	Mechanical strength	(Under consideration)
iv)	Protection against electrical shock	40 of IS : 302-1973*
v)	Insulation resistance and leakage current (hot)	42 of IS : 302-1973*
vi)	Earthing connection	38 of IS : 302-1973*
vii)	Input	45 of IS : 302-1973*
viii)	Temperature-rise limit	41 of IS : 302-1973*
ix)	Temperature variation and differential	9.3.2
x)	Operation of temperature fuse or cut-out	9.3.4 or 9.3.5
xi)	Heating-up time	9.3.6

*General and safety requirements for household and similar electrical appliances (*fourth revision*).

*General and safety requirements for household and similar electrical appliances (*fourth revision*).

9.1.3 Routine Tests — The following shall constitute routine tests:

- a) Visual examination and inspection (*see* **9.3.1**),
- b) Protection against electric shock (*see* **40** of IS : 302-1973*),
- c) Insulation resistance and leakage current (hot) (*see* **42** of IS : 302-1973*),
- d) Earthing connection (*see* **38** of IS : 302-1973*), and
- e) Input (*see* **45** of IS : 302-1973*).

9.2 General Conditions for Tests

9.2.1 Test Voltage — The provisions of **26.3** of IS : 302-1973* shall apply.

9.2.2 Ambient Temperature — The ambient temperature during the performance test may be kept at any value between 15 to 40°C and during the test the temperature shall not vary by more than $\pm 5^{\circ}\text{C}$.

9.2.3 Test Temperatures — The temperature variation and differential test shall be performed at $500 \pm 20^{\circ}\text{C}$ and at a higher temperature which is within 50°C of the maximum temperature. The temperature limit test shall be performed at the maximum temperature $\pm 10^{\circ}\text{C}$.

9.2.4 Measurement of Temperatures — The measurement of temperatures for the purpose of temperature variation and differential tests shall commence when the steady state period is reached.

9.2.4.1 The temperature measurements shall be made with Pt/13 percent Rh-Pt thermocouples made from 0.5 mm thick wire with the junctions enclosed in a protective sheath of mullite with wall thickness not more than 1.5 mm. The thermocouple junctions will be located at different points specified in the stated performance as quoted on the equipment marking, instructions for use or specification literature supplied by the manufacturer. The thermocouples will be connected to a suitable multi-channel recorder or to suitable direct reading pyrometer with channel selection switch.

9.2.5 Arrangement of the Furnace — The furnace shall be tested on a table or stand 1 m above floor level and located so as to be protected from direct heat source or draughts. When carrying out performance tests, it should be empty but with the hearth plate, if any, supplied with the furnace kept in position, and all vent holes or peep holes adjusted as per the manufacturers instructions.

*General and safety requirements for household and similar electrical appliances (fourth revision).

9.3 Schedule of Tests

9.3.1 Visual Examination and Inspection — Each furnace shall be examined and inspected for general construction and marking requirements specified in this standard. The necessary operating instructions and specification of stated performance shall also be checked.

9.3.2 Temperature Variation and Differential Test — With the measuring thermocouples located as required to check the stated performance and connected to a measuring or recording instrument the temperatures shall be noted or recorded at least once in three minutes at each location of a thermocouple junction over a span of two hours during the steady state period. The maximum difference of temperature observed at any two locations during the test shall constitute the temperature variation of the furnace at the test temperature, and the maximum difference of temperature during the test observed at any one location shall constitute the temperature differential of the furnace at the test temperature.

9.3.2.1 The temperature variation of the furnace measured as in **9.3.2** shall not exceed the limits specified in the stated performance.

In the case of furnaces fitted with an automatic temperature controller the temperature differential of the furnace measured as in **9.3.2** shall not exceed the limits specified in the stated performance.

9.3.3 Temperature Drift — A furnace fitted with a temperature controller shall be operated continuously for 24 hours in the steady state after conclusion of the test as in **9.3.2** and the furnace temperature shall be recorded or noted at intervals not exceeding 60 minutes during the whole period and at its conclusion. The difference between the minimum and maximum temperature obtained shall constitute the temperature drift, and it shall not exceed the value specified as stated performance.

9.3.4 Test for Operation of Temperature Fuse — With the furnace arranged to operate with the rated input the temperature of the furnace shall be allowed to rise without any constraints until the temperature fuse interrupts the supply by its fusion. The furnace shall be allowed to cool down to below 100°C and the fuse replaced with another of identical characteristics. The furnace shall then be switched on again at rated input until interruption by the temperature fuse. The cycle will be performed six times in all noting the maximum temperature reached. This shall not differ at any time by more than 10°C from the nominal fusion temperature of the fuse stated by the manufacturer and the furnace shall not be found to have been damaged in any way after conclusion of the test.

9.3.5 Test for Operation of Thermal Cut-Out — With the furnace arranged to operate with the rated input the temperature of the furnace shall be allowed to rise without any constraints until the cut-out interrupts the supply. The minimum temperature reached shall be noted and the furnace allowed to cool below 100°C. The cut-out shall be reset as directed by the manufacturer and the cycle repeated. After six such operations of the cut-out, the furnace shall not be found to have been damaged in any way.

9.3.6 Heating-Up Time — At the end of the test as in **9.3.5** the furnace shall be cooled down to the test ambient temperature and the furnace switched on with the related input or maximum setting in case of thermostatically controlled furnaces without any constraints on the temperature-rise. The time required to attain the maximum temperature shall not exceed the heating-up time stated by the manufacturer.